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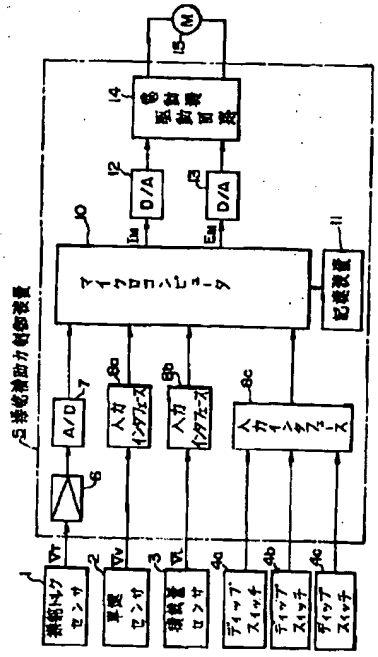
(54)【発明の名称】　電動式動力舵取装置

(57)【要約】

【目的】　広範囲の産業用車両に適用可能な汎用性のある電動式動力舵取装置を提供する。

【構成】　操舵トルクを検出する操舵トルクセンサ１と車両の走行状態を検出する車速センサ２及び積載量センサ３の何れか一方とを備えていると共に、車両特性を選択する選択手段としてのディップスイッチ４ａ～４ｃを備えており、さらに記憶装置１１に多数の出力電流特性及び回転数特性と、これら特性を車両特性番号と車両状態変数とにより選択する配憶テーブルとを記憶しておき、これらの特性を産業車両の諸元に応じてディップスイッチ４ａ～４ｃで設定することにより、車両に適合した特性で操舵補助機能を発揮する。



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後、バッテリーフォークリフトの起動スイッチをオン状態とすると、これに応じて操舵補助力制御装置5に電源が供給され、マイクロコンピュータ10で図6に示す処理が実行される。すなわち、ステップ①で、ディップスイッチ4a～4cのスイッチ信号を読込み、次いでステップ②に移行して、車速センサ2及び積載量センサ3の各検出値を読込み、次いでステップ③に移行して、車両が据え切り状態であるか否かを判定する。この判定は、車速センサ2の車速検出値V_rが予め設定した車速閾値V_{r1}未満であり、且つ積載量センサ3の積載量検出値V_lが予め設定した積載量閾値V_{l1}未満であるか否かを判定することにより行い、$V_r < V_{r1}$で且つ$V_l < V_{l1}$であるときには、据え切り状態であると判断しステップ③aに移行して、車両状態変数Bを“0”に設定してからステップ④に移行し、$V_r \geqq V_{l1}$又は$V_l \geqq V_{l1}$であるときには、ステップ③bに移行する。

【0018】このステップ③bでは、$V_r \geqq V_{r1}$且つ$V_l \geqq V_{l1}$であるか否かを判定し、$V_r \geqq V_{r1}$又は$V_l \geqq V_{l1}$であるときには、ステップ③cに移行して、車両状態変数Bを“1”に設定してからステップ④に移行し、$V_r \geqq V_{l1}$且つ$V_l \geqq V_{l1}$であるときにはステップ③dに移行して、車両状態変数Bを“2”に設定してからステップ④に移行する。

【0019】ステップ④では、車両特性番号A及び車両状態変数Bをもとに、図4の記憶テーブルを参照して、車両特性及び車両状態に最適な出力電流特性T_i及び回転数N_iを算出してからステップ⑤に移行する。このステップ⑤では、操舵トルクセンサ1のトルク検出信号V_tを読込み、次いでステップ⑥に移行してトルク検出信号V_Tから中立電圧V_0を減算して、右操舵を正、左操舵を負とする操舵トルク検出値T_sを算出し、次いでステップ⑦に移行して、図3の出力電流特性マップにおける出力電流特性T_iを参照して電動機駆動電流指令値I_sを算出し、次いでステップ⑧に移行して、ステップ④で算出した回転数N_iに対応する電動機印加電圧指令値E_sを算出してからステップ⑨に移行する。

【0020】ステップ⑨では、算出された電動機駆動電流指令値I_s及び電動機印加電圧指令値E_sをD／A変換器12及び13を介して電動機駆動回路14に出力してから処理を終了する。なお、図6の処理において、ステップ③～③dの処理及び車速センサ2，積載量センサ3で車両状態検出手段が構成され、ステップ④の処理及び図5の記憶テーブルで選択手段が構成されている。

【0021】したがって、今、車両特性番号Aが“0”に設定されており、車両が停車状態にあって積載量が少ないものとすると、この状態では、後輪側の操舵輪の輪荷重は最大となっている。このとき、図6の処理が実行されると、車速センサ2の車速検出信号V_rが零であり、積載量センサ3の積載量検出信号V_lも零に近い値であるので、ステップ③からステップ③aに移行して、

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車両状態変数Bが“0”に設定される。

【0022】このため、ステップ④で出力電流特性がT_1に、回転数がN_1に夫々設定される。このとき、ステアリングホイールが中立状態で非操舵状態であるときには、操舵トルクが零であるので、操舵トルクセンサ1から出力される操舵トルク検出信号V_Tが中立電圧V_0となっており、ステップ⑥で算出される操舵トルク検出値T_sが零となっている。このため、ステップ⑦で算出される電動機駆動電流指令値I_sも零となっており、これが電動機駆動回路14に供給されるので、この電動機駆動回路14では電動機15に対する駆動電流の供給を停止しており、電動機15は停止状態にある。

【0023】この非操舵中立状態から、ステアリングホイールを右操舵（又は左操舵）する所謂据切りを行うと、トルクセンサ1のトルク検出信号V_Tに基づく操舵トルク検出値T_sが設定値$\pm T_1$を越えたときに、そのときの操舵トルク検出値T_sに応じた電動機駆動電流指令値I_sが算出され、且つ回転数N_1に対応する電動機印加電圧指令値E_sが算出され、これらが電動機駆動回路14に出力される。なお、トルクセンサ1の検出電圧は、操舵トルクに比例するものであるが、トルクセンサ1に設けられた機械的ストッパーによって上限値V_H及び下限値V_Lを越えることはない。

【0024】したがって、電動機駆動回路14で、操舵トルクに対応した電動機駆動電流で且つ高い回転数N_1となる印加電圧E_1が直流電動機15に供給される。その結果、直流電動機15で、軽積載量時で且つ据切り時である重負荷時に応じた操舵補助トルクを発生すると共に、高回転数N_1に設定されることからステアリングホイールが電動機回転数より高い回転数で操舵されることはないので、直流電動機15で回生制動を生じることがなく、軽い操舵を行うことができる。

【0025】この据切り状態から、車両が走行を開始し、車速センサ2から出力される車速検出信号V_rが車速閾値V_{r1}以上となる比較的高速走行状態となると、図6の処理において、ステップ③からステップ③bを経てステップ③cに移行して、車両状態変数Bが“1”に設定される。このため、ステップ④で、図5の記憶テーブルを参照して出力電流特性がT_4に設定されると共に回転数がN_5に設定される。この結果、操舵トルクセンサ1で検出されるトルク検出信号V_Tが据え切り状態と同じ値であっても、電動機15に供給される電動機駆動電流は据え切り時の2／3程度となるので、電動機15で発生される操舵補助トルクも小さくなり、しかも電動機15の回転数が半分程度に低下するので、急操舵を行ったときには、電動機15の出力軸にステアリング系からその回転数より高い回転数が伝達され、電動機15の出力軸が外力によって回転されることとなって回生制動状態に移行し、操舵抵抗を発生し、ステアリングホイールの操舵感覚が走行状態に応じて重くなり、不用意な急操

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舵を防止することができる。

【0026】一方、バッテリーフォークリフトの積載重量が多く、積載量センサ3から出力される積載量検出信号V_Lが大きいときには、車両が停車状態でもステップ③からステップ③bを経てステップ③cに移行することになり、車両状態変数Bが“1”に設定されることから、上述した高速走行状態と同様の操舵感覚を得ることができ、この状態で車両が走行を開始して高速走行状態となると、ステップ③bからステップ③dに移行して車両状態変数Bが“2”に設定されて、ステップ④で出力電流特性がT_7に、回転数がN_{12}に設定されることから、操舵トルク検出信号に対する電動機出力電流の比及び回転数がさらに小さくなるので、電動機15で発生する操舵補助トルクがより小さくなると共に、急操舵よりは緩やかな操舵でも電動機15が回生制動状態となることにより、より大きな操舵抵抗感覚を与えて、走行安定性を確保することができる。

【0027】このように、上記実施例によると、トルクセンサで検出した操舵トルク検出値に応じて電動機の出力トルクを制御すると共に、車速検出値及び／又は積載量検出値に応じて電動機の回転数を可変制御することができ、これらの出力トルク特性及び回転数特性を適用車両の特性に合わせて選択することができるので、操舵力制御装置5を広範囲の車種に適用することが可能となり、汎用性を向上させることができる。

【0028】なお、本実施例では、積載量センサ31でフォーク上の積載物荷重を直接検出する場合を説明したが、操舵輪の輪荷重を検出し、この輪荷重変化に対応して回転数を変更するようにしてもよい。また、本実施例では、選択手段としてディップスイッチ4a～4cを適用したが、これに限定されるものではなく、ジャンパー線、テンキー等の入力手段を適用することができる。

【0029】さらに、本実施例では、走行状態検出手段として、車速センサ21及び積載量センサ31の双方を適用した場合を説明したが、これらの何れか一方を省略するようにしてもよい。さらにまた、本実施例では、操舵補助力制御装置2をマイクロコンピュータ10で構成する場合について述べたが、関数発生器、車速又は積載量に応じてトルク検出電圧を制限する電圧リミッタ、その出力が供給されるパルス幅変調回路、その出力が供給される電動機駆動回路等のアナログ回路を適用してアナログ制御することもできる。

【0030】また、本実施例では、後輪操舵型のフォークリフトについて説明したが、これに限らず、前輪操舵

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型のフォークリフトにも本発明を適用することができ、この場合には、積載量が多いときに出力電流特性及び回転数特性を大きく設定すればよい。

【0031】

【発明の効果】以上のように、本発明に係る電動式動力舵取装置によれば、操舵トルク検出手段の操舵トルク検出値に応じて電動機に供給する出力電流を制御し、且つ車両の車速、積載量等による走行状態を走行状態検出手段で検出し、この走行状態検出手段の走行状態検出値に応じて制御手段で電動機の回転数を制御するようにし、さらに多数の出力電流特性及び回転数特性を予め記憶装置に記憶しておき、これを選択手段で選択するようにしたので、1つの制御装置で多種類の車種に適用することが可能となり、汎用性を向上させることができる効果が得られる。

【図面の簡単な説明】

【図1】本発明のクレーム対応図である。

【図2】本発明に係る電動式動力舵取装置の一実施例を示すブロック図である。

【図3】操舵トルク検出値と電動機駆動電流との関係を示す特性線図である。

【図4】電動機の出力トルクと駆動電流及び回転数との関係を示す特性線図である。

【図5】車両特性番号と車両状態との関係を示す記憶テーブルを示す説明図である。

【図6】マイクロコンピュータの処理を示すフローチャートである。

【図7】操舵トルクとセンサ出力との関係を示す特性線図である。

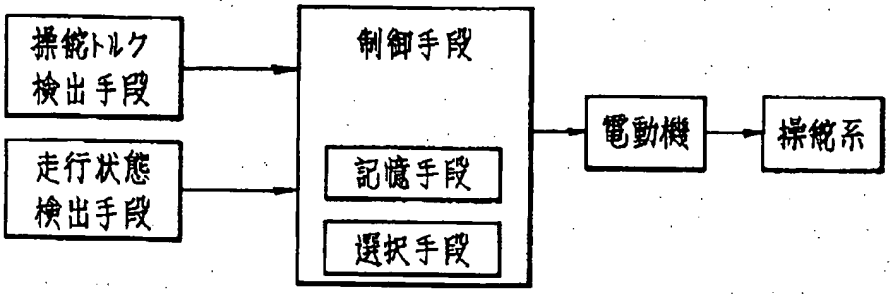
【図8】センサ出力と電動機電流との関係を示す特性線図である。

【図9】操舵トルクと電動機電流との関係を示す特性線図である。

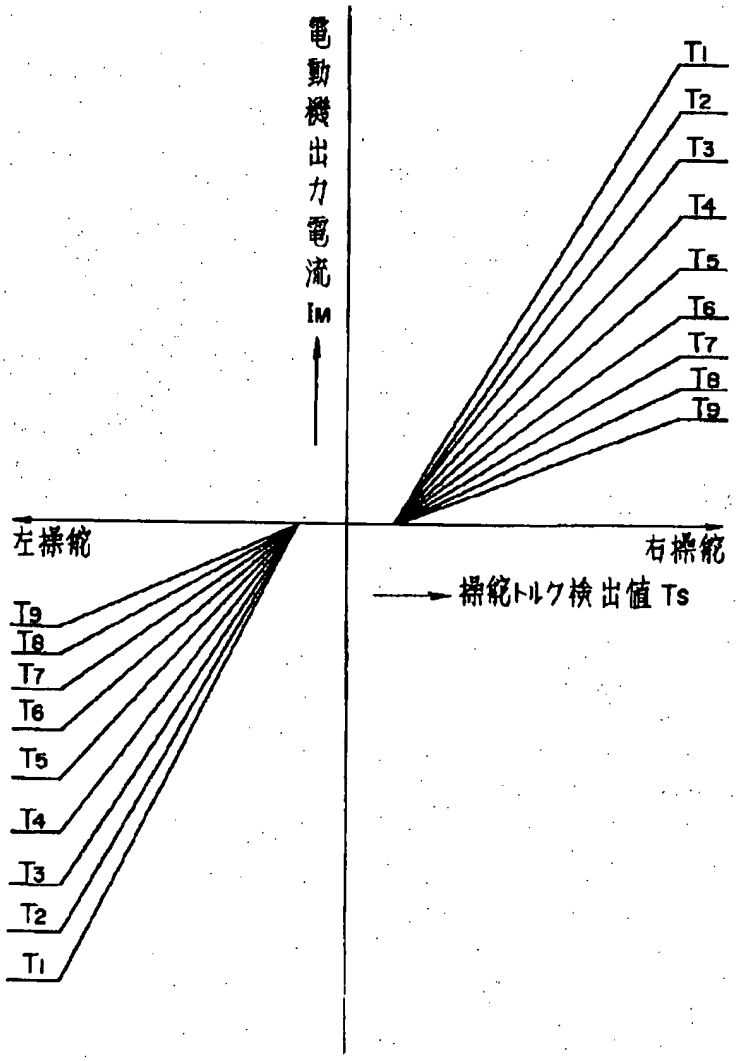
【符号の説明】

1　操舵トルクセンサ
2　車速センサ
3　積載量センサ
4a～4c　ディップスイッチ
5　操舵補助力制御装置
10　マイクロコンピュータ
11　記憶装置
14　電動機駆動回路
15　直流電動機

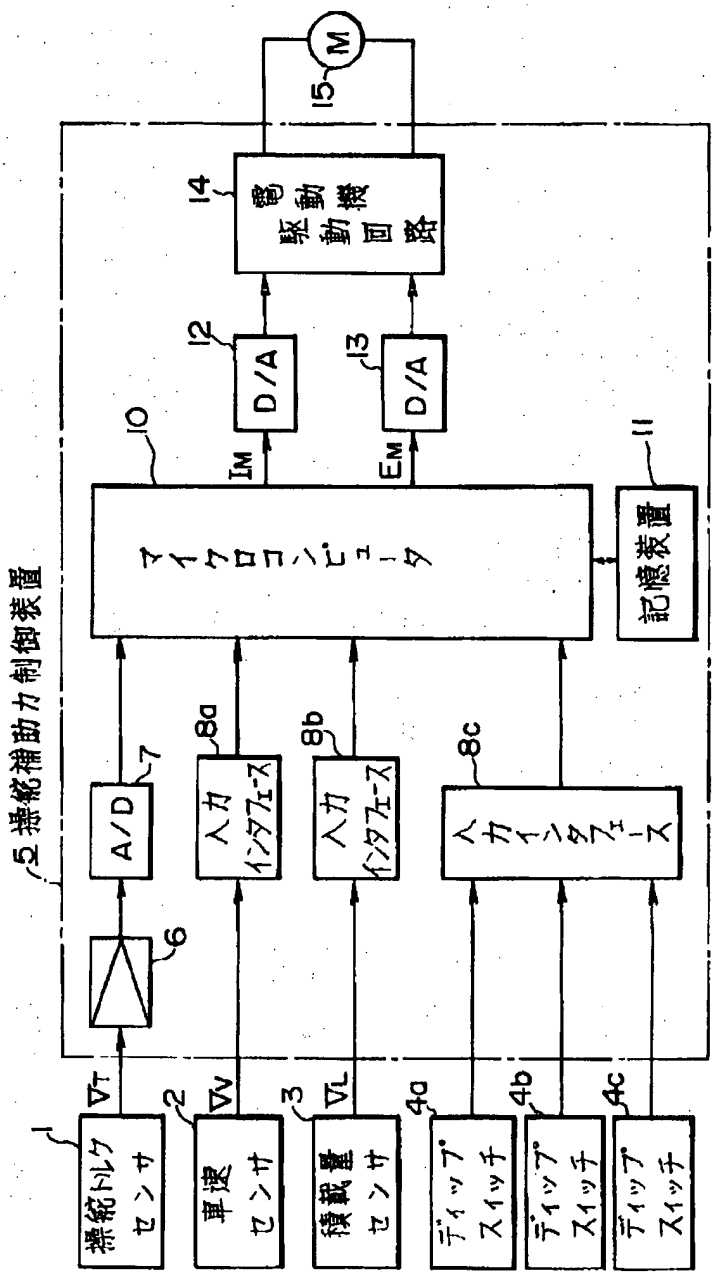
【図1】


操舵トルク
検出手段
走行状態
検出手段
制御手段
記憶手段
選択手段
電動機
操舵系

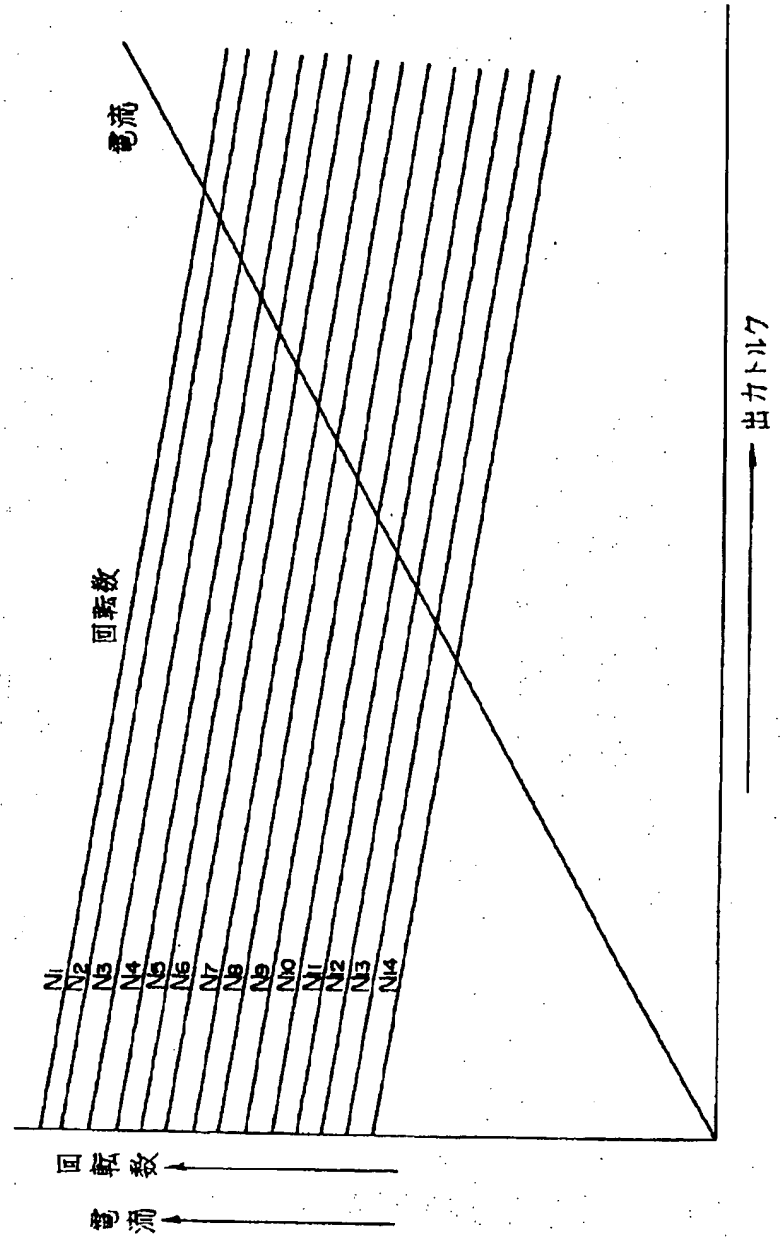
【図3】


電動機出力電流 IM
T1
T2
T3
T4
T5
T6
T7
T8
T9
左操舵
右操舵
操舵トルク検出値 Ts

【図2】


操舵補助力制御装置
操舵トルクセンサ
車速センサ
積載量センサ
ディップスイッチ
ディップスイッチ
ディップスイッチ
A/D
入力インタフェース
入力インタフェース
入力インタフェース
マイクロコンピュータ
記憶装置
D/A
D/A
電動機駆動回路
M

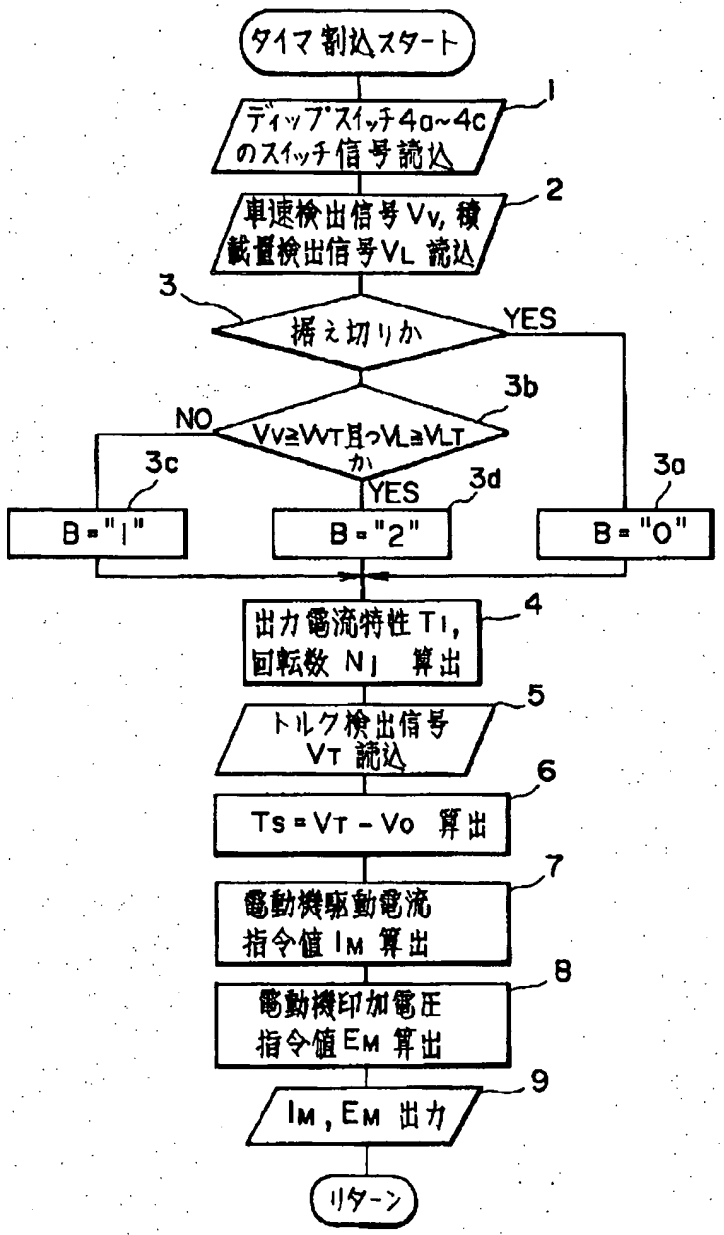
【図4】



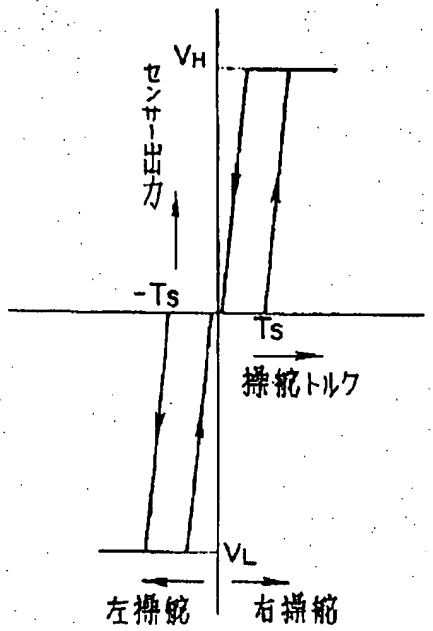
【図5】

車両状態変数B ＼ 車両特性番号A	"φ"（搭切り）		"1"（車速一定以上OR積載有り）		"2"（車速一定以上AND積載有り）	
	出力電流特性(MAP)	回転数特性	出力電流特性(MAP)	回転数特性	出力電流特性(MAP)	回転数特性
0	T_1	N_1	T_4	N_9	T_7	N_{12}
1	↑	N_2	↑	↑	↑	↑
2	↑	N_3	↑	↑	↑	↑
3	T_2	N_4	T_5	N_{10}	T_8	N_{13}
4	↑	N_5	↑	↑	↑	↑
5	↑	N_6	↑	↑	↑	↑
6	T_3	N_7	T_6	N_{11}	T_9	N_{14}
7	↑	N_8	↑	↑	↑	↑

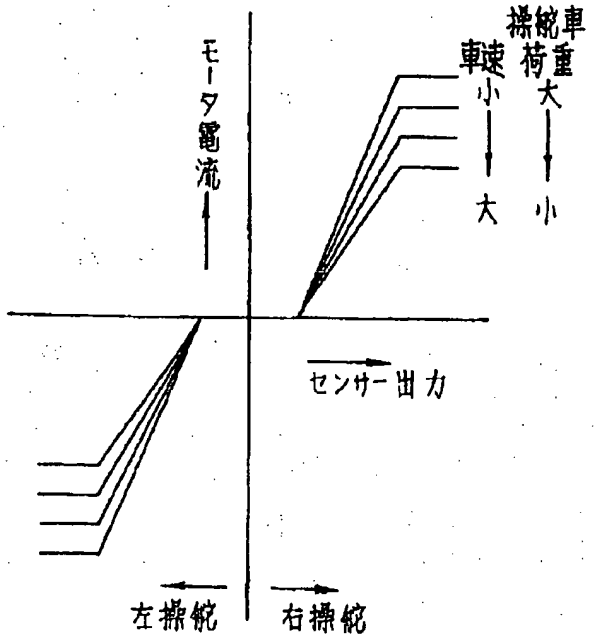
【図6】


タイマ割込スタート
ディップスイッチ4a~4cのスイッチ信号読込
1
車速検出信号Vv, 積載検出信号VL 読込
2
3
据え切りか
YES
NO
3b
Vv≧VvT且つVL≧VLT か
3c
3d
3a
B="1"
B="2"
B="0"
出力電流特性TI, 回転数 NI 算出
4
トルク検出信号 VT 読込
5
6
Ts=VT-Vo 算出
7
電動機駆動電流指令値 IM 算出
8
電動機印加電圧指令値 EM 算出
9
IM, EM 出力
リターン

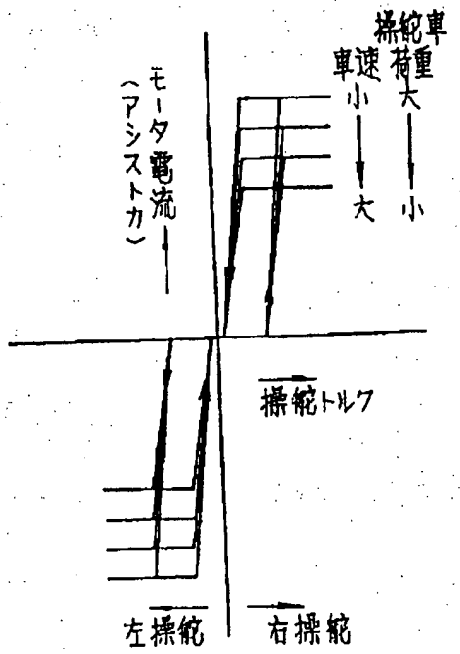
【図7】


VH
センサー出力
-Ts
Ts
操舵トルク
VL
左操舵
右操舵

【図8】


モータ電流
車速 小 → 大
操舵荷重 大 → 小
センサー出力
左操舵
右操舵

【図9】


モータ電流
（アシストカ）
車速 小 → 大
操舵荷重 大 → 小
操舵トルク
左操舵
右操舵

PATENT ABSTRACTS OF JAPAN

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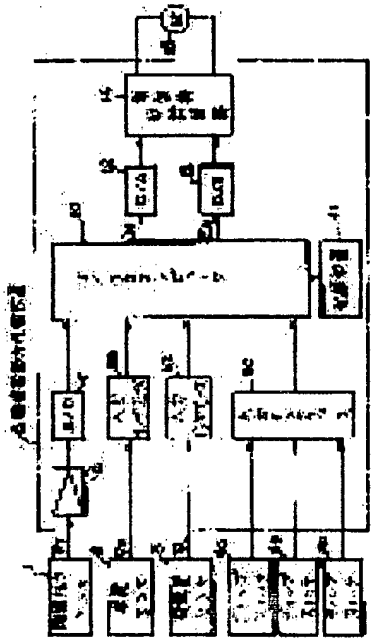
(54) MOTOR-DRIVEN POWER STEERING

(57)Abstract:
PURPOSE: To provide a general-purpose motor-driven power steering applicable to industrial vehicles in a wide range.
CONSTITUTION: There are provided a steering torque sensor for detecting steering torque, either one of a vehicle speed sensor for detecting the travel state of a vehicle and a loadage sensor 3, and dipping switches 4a-4c serving as selecting means for selecting vehicle characteristics. A storage device 11 is previously stored with numerous output current characteristics and rotating speed characteristics as well as with a storage table for selecting these characteristics by vehicle characteristic numbers and vehicle state parameters. These characteristics are set by the dipping switches 4a-4c according to the item of an industrial vehicle so as to display steering assisting function with the characteristics suitable for the vehicle.



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CLAIMS

[Claim(s)]
[Claim 1] A steering torque detection means to detect the steering torque of a steering system, and a run state detection means to detect the run state of a car, Based on the motor which generates the steering auxiliary force to said steering system, and the detection value of said steering torque detection means, the output current property over the steering torque to said motor is controlled. And it sets to electromotive power steering equipped with the control means which controls the rotational-speed property over the output torque of the motor concerned based on the run state detection value of said run state detection means. Said control means is electromotive power steering characterized by having a storage means to memorize many output current properties and rotational-speed properties, and a selection means to choose each property memorized by this storage means.

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Industrial Application] This invention is especially applied to industrial cars, such as a dc-battery fork lift truck, about the electromotive power steering which generates the steering auxiliary force with a motor, and is suitable.
[0002]
[Description of the Prior Art] There are some which are indicated as conventional electromotive power steering by JP,1-244973,A which these people proposed previously. This conventional example is equipped with the storage table corresponding to the characteristic ray Fig. showing the relation of the steering torque and the motor current command value which make a parameter a vehicle

speed detection value as shown in that Fig. 7, and he is trying to determine a motorised current [based on the steering torque detection value which detected this storage table by the steering torque sensor]. namely, the time of a low speed with a small vehicle speed detection value — being the so-called — it sets, and a big motorised current is generated to a steering torque detection value, and he generates the big steering auxiliary force, and is trying to generate a small motorised current to a steering torque detection value, and to generate the small steering auxiliary force in the end condition, at the time of the high-speed transit with a large vehicle speed detection value

[0003]

[Problem(s) to be Solved by the Invention] However, although it is a car with a small steering wheel load and the small ratio of a manual control force and the steering auxiliary force and is effective in the large car of vehicle speed variation in the above-mentioned conventional electromotive power steering like a passenger car If steering wheel loads, such as a dc-battery fork lift truck, were in the car with little vehicle speed variation greatly [it is large and / the ratio of a manual control force and the steering auxiliary force], there was a trouble that the steering auxiliary force adjustable range could not continue throughout the small vehicle speed, and a suitable steering feeling could not be obtained.

[0004] Namely, on the character of the fork lift truck a steering wheel load is large and runs only at a low speed, While the output gain over a steering torque detection value will become very large as the property of the steering torque sensor which detects steering torque shows drawing 6 since the big steering auxiliary force is the need in all vehicle speed range Since the steering wheel load is large, and handle steering is difficult, the big steering auxiliary force is required of the smallness steering auxiliary force, and since the peak-output-current (motor maximum current) value of a control unit cannot be made not much small to vehicle speed change as shown in drawing 8 , the adjustable range becomes narrow. Therefore, since it set even if the motor current gain over steering torque hardly changes but makes it a vehicle speed induction mold, as shown in drawing 9 , and the control force at the time of the end and transit seldom changed, a property had the trouble that transit stability was seldom improvable, when the property of the steering auxiliary force over steering torque was set as the steering auxiliary force property with emphasis on the set end.

[0005] Moreover, by controlling the rotational speed of a motor according to the run state, i.e., the vehicle speed, or movable load of a car Although improving steering feeling by setting, enlarging motor rotational speed at the time of the end, making it not produce regenerative braking, making motor rotational speed small according to the vehicle speed at the time of transit, producing regenerative braking, and giving

steering resistance is also considered By setting and setting it as a steering auxiliary force property with emphasis on the time of the end, set, perform light steering at the time of the end, according to this motor rotational-speed control, at the time of transit, can give the steering resistance by regenerative braking, can perform heavy steering, but Since it did not change into the regenerative-braking condition unless it rotated the handle earlier than the rotational speed of a motor, there was a trouble that so large a control range could not be taken.

[0006] Consequently, in order to generate the optimal auxiliary control force according to the run state of a car Although it is desirable to combine the both sides of the motor output current property over steering torque and the rotational-speed property over a motor output torque, by the dc-battery fork lift truck Since there are various types of a car from which a permissible movable load differs and a motor output current property naturally differs from a rotational-speed property by these types of a car, it is difficult to manufacture a control unit common to all types of a car, and the present condition is manufacturing the control unit of varieties according to a **** type of a car.

[0007] Then, the purpose of this invention is to offer electromotive power steering applicable in common to various types of a car.

[0008]

[Means for Solving the Problem] In order to solve the above-mentioned technical problem, the electromotive power steering concerning this invention A steering torque detection means to detect the steering torque of a steering system as shown in the Fig. corresponding to a claim of drawing 1 , A run state detection means to detect the run state of a car, and the motor which generates the steering auxiliary force to said steering system, Based on the detection value of said steering torque detection means, the output current property over the steering torque to said motor is controlled. And it sets to electromotive power steering equipped with the control means which controls the rotational-speed property over the output torque of the motor concerned based on the run state detection value of said run state detection means. Said control means has the configuration equipped with a storage means to memorize many output current properties and rotational-speed properties, and a selection means to choose each property memorized by this storage means.

[0009]

[Function] While controlling the output current over the motor which generates the steering auxiliary force based on a steering torque detection value by this invention, by detecting either [at least] the vehicle speed or a steering wheel load with a run state detection means, the run state of a car is detected and the rotational speed of the motor corresponding to steering torque is controlled by the control means

according to this. At this time, the control means of the electromotive power steering applied to various types of a car can be communalized by memorizing many properties beforehand and choosing with a selection means as the output current property of a motor, and a rotational-speed property of a motor, according to the type of a car which applies these properties.

[0010]

[Example] Drawing 2 is the block diagram showing one example at the time of applying this invention to the so-called counter balance type with which a steering wheel load decreases in the state of loading by a steering wheel load serving as max in the state of un-loading with a rear wheel steering mold of fork lift truck. One is a steering torque sensor which detects the steering torque produced according to steering of a steering wheel among drawing. This torque sensor 1 As shown in drawing 6 mentioned above, in the condition that a steering wheel is in a neutral condition Predetermined neutral electrical potential difference V0 If it outputs and the right end of the steering wheel is carried out from this the steering torque at that time — responding — neutral electrical potential difference V0 if the left end of the increasing electrical potential difference is carried out — the steering torque at that time — responding — neutral electrical potential difference V0 the electrical potential difference which decreases — respectively — torque detecting signal VT ****** — it outputs.

[0011] 2 is the vehicle speed detecting signal VV which becomes with the voltage signal according to the vehicle speed. The speed sensor to output and which consists of tacometer generators, for example, and 3 are the burden detecting signal VL which becomes with the voltage signal according to the movable load on the fork which lays a loading object. It is the burden sensor to output and which consists of load cells, for example. Moreover, 4a-4c are the DIP switches of the triplet for car property selection which constitutes a selection means, and can choose the car property numbers A from "0" to "7."

[0012] And the torque detecting signal VT of the steering torque sensor 1, the vehicle speed detecting signal VV of a speed sensor 2, and the burden detecting signal VL of the burden sensor 3 And the switch signal of DIP switches 4a-4c is inputted into steering auxiliary force-control equipment 5. This steering auxiliary force-control equipment 5 is the torque detecting signal VT of the steering torque sensor 1. Amplifier 6 and A/D converter 7 are minded. The detecting signal VV of a speed sensor 2, and detecting signal VL of the burden sensor 3 And the microcomputer 10 into which the switch signal of DIP switches 4a-4c is inputted through the input interfaces 8a, 8b, and 8c, respectively, The storage 11 which consists of ROMs and RAM which were connected to this microcomputer 10, Motor drive current command value IM outputted from a microcomputer 10 And motor applied-voltage command

value EM D/A converters 12 and 13 changed into analog voltage, It has the motor drive circuit 14 where the conversion output of these D/A converters 12 and 13 is inputted. It is the motor drive current command value IM in the motor drive circuit 14. And motor applied-voltage command value EM The drive current and rotational frequency of the direct current motor 15 which is based and generates steering auxiliary torque to a steering system are controlled.

[0013] Torque detection value TS based on the torque detecting signal of the steering torque sensor 1 beforehand shown [the ROM] in storage 11 at drawing 3 Motor drive current IM Nine kinds of characteristic ray drawing T1 -T9 showing relation While memorizing as a map The parameter chosen with DIP switches 4a-4c which 14 kinds of characteristic ray Fig. N1 showing the relation of the motor output torque and rotational frequency which are shown in drawing 4 - N14 are memorized as a map, and are shown in drawing 5 , The storage table which sets up an output current property and an engine-speed property according to the car condition mentioned later is memorized.

[0014] And while a microcomputer 10 reads the switch signal of the DIPU switches 4a-4c Based on read in and these, an output current property and a rotational frequency property are set up for each detection value of a speed sensor 2 and the burden sensor 3 with reference to the storage table of drawing 5 . Subsequently, torque detecting signal VT of the steering torque sensor 1 Read in and from now on, it will be the neutral electrical potential difference V0. It subtracts and responds in the direction of steering torque. Right steering Forward, Torque detection value TS which makes left steering negative It computes and is this torque detection value TS. The output current property set to the basis to motor drive current command value IM While computing Set-up rotational frequency NM Corresponding motor applied-voltage command value EM It computes and is the motor drive current command value IM. And motor applied-voltage command value EM Each is outputted to the motor drive circuit 14 through D/A converters 12 and 13.

[0015] Next, actuation of the above-mentioned example is explained. First, when building steering auxiliary force-control equipment 5 into a dc-battery fork lift truck, the property of a dc-battery fork lift truck is grasped. In this, set and steering during the stop of an application type of a car beforehand [so-called] [whether steering auxiliary torque required at the time of the end is large, and] By investigating whether a wheel load change according [whether a ratio with steering torque when it sets and the steering auxiliary torque and the car at the time of the end are running above the fixed vehicle speed is large, and] to change of loading weight is large or small The car property number A which suits from car property number "0"- "7" indicated in the same property symmetry table as the storage table shown in drawing 5 is chosen, and

this car property number A is set as DIP switches 4a–4c.

[0016] namely, when it sets and you need big steering auxiliary torque at the time of the end Choose and set any one of the "0"– "3" as a car property number A, and so big steering auxiliary torque is not needed at the time of the end. By running above the fixed vehicle speed, when loading weight is large, and wheel load is small, "6" or "7" is chosen as a car property number A, and these car property numbers are set as DIP switches 4a–4c.

[0017] Thus, if the start switch of a dc–battery fork lift truck is made into an ON state after setting up the car property number A, according to this, a power source will be supplied to steering auxiliary force–control equipment 5, and processing shown in drawing 6 with a microcomputer 10 will be performed. That is, by step **, the switch signal of DIP switches 4a–4c is read, and subsequently to step ** it shifts, and subsequently to step ** it shifts, a car sets, and each detection value of a speed sensor 2 and the burden sensor 3 is judged [read in and] for whether it is in an end condition. This judgment is the vehicle speed detection value VV of a speed sensor 2. It is under the vehicle speed threshold VVT set up beforehand. And burden detection value VL of the burden sensor 3 When it performs by judging whether it is under the burden threshold VLT set up beforehand, and it is VV <VVT and it is VL <VLT It sets, judges that it is in an end condition, and shifts to step **a, after setting the car state variable B as "0", it shifts to step **, and when it is VV >=VLT or VL >=VLT, it shifts to step **b.

[0018] In this step **b, judge, and when it is VV >=VVT or VL >=VLT, whether they are VV >=VVT and VL >=VLT It shifts to step **c, after setting the car state variable B as "1", it shifts to step **, and when it is VV>=VLT and VL >=VLT, after shifting to step **d and setting the car state variable B as "2", it shifts to step **.

[0019] In step **, the storage table of drawing 4 is referred to based on the car property number A and the car state variable B, and they are a car property and the optimal output current property Ti for a car condition. And rotational frequency Nj After computing, it shifts to step **. this step ** — torque detecting signal VT of the steering torque sensor 1 read in –– subsequently –– step ** –– shifting –– torque detecting signal VT from –– neutral electrical potential difference V0 It subtracts. Steering torque detection value TS which makes right steering as forward and makes left steering negative Compute and, subsequently to step **, it shifts. Output current property Ti in the output current property map of drawing 3 Rotational frequency Nj which computed the motor drive current command value IM by having referred to, shifted subsequently to step ** and was computed by step ** Corresponding motor applied–voltage command value EM After computing, it shifts to step **.

[0020] Motor drive current command value IM computed in step ** And motor

applied-voltage command value EM Processing is ended after outputting to the motor drive circuit 14 through D/A converters 12 and 13. In addition, in processing of drawing 6 , a car condition detection means consists of processing and the speed sensor 2 of step ** - **d, and a burden sensor 3, and the selection means consists of processing of step **, and a storage table of drawing 5 .

[0021] Therefore, now, the car property number A is set as "0", and if a car is in a stop condition and considers as what has few burden, in this condition, the wheel load of the steering wheel by the side of a rear wheel serves as max. If processing of drawing 6 is performed at this time, it is the vehicle speed detecting signal VV of a speed sensor 2. It is zero and is the burden detecting signal VL of the burden sensor 3. Since it is a value near zero, it shifts to step **[from step **] a, and the car state variable B is set as "0."

[0022] For this reason, an output current property is T1 at step **. A rotational frequency is N1. It is set up, respectively. Steering torque detecting signal VT outputted from the steering torque sensor 1 since steering torque is zero when a steering wheel is in the condition of not steering, in the state of neutrality at this time Neutral electrical potential difference V0 Steering torque detection value TS which has become and is computed by step ** It is zero. For this reason, since the motor drive current command value IM computed by step ** serves as zero and this is supplied to the motor drive circuit 14, in this motor drive circuit 14, supply of the drive current over a motor 15 is suspended, and a motor 15 is in a idle state.

[0023] If the so-called ****** which carries out right steering (or left steering) of the steering wheel is performed from this non-steering neutral condition, it is the torque detecting signal VT of a torque sensor 1. Based steering torque detection value TS Set point**T1 When it exceeds Steering torque detection value TS at that time Motor drive current command value IM to which it responded It is computed and is a rotational frequency N1. Corresponding motor applied-voltage command value EM It is computed and these are outputted to the motor drive circuit 14. In addition, the detection electrical potential difference of a torque sensor 1 is a upper limit VH by the mechanical stopper formed in the torque sensor 1 although it is proportional to steering torque. And lower limit VL It does not exceed.

[0024] Therefore, rotational frequency N1 high in the motor drive circuit 14 which is a motor drive current corresponding to steering torque Becoming applied voltage E1 A direct current motor 15 is supplied. Consequently, while generating the steering auxiliary torque according to the time of heavy loading which it is at the amount time of light load, and at the ****** time with a direct current motor 15, it is the high rotational frequency N1. Since it is set up and a steering wheel is not steered at a rotational frequency higher than a motor rotational frequency, regenerative braking is

not produced with a direct current motor 15, and light steering can be performed.
[0025] vehicle speed detecting signal VV to which a car starts transit and is outputted from a speed sensor 2 from this ****** condition it becomes beyond the vehicle speed threshold VVT — if it will be in a high-speed run state comparatively, pass step **[from step **] b in processing of drawing 6 R> 6 — it shifts to step **c and the car state variable B is set as "1." For this reason, the storage table of drawing 5 is referred to by step **, and an output current property is T four. A rotational frequency is N9 while being set up. It is set up. Consequently, torque detecting signal VT detected by the steering torque sensor 1 Since the motor drive current supplied to a motor 15 is set and becomes about [at the time of the end] 2/3 even if it sets and is the same value as an end condition Since the steering auxiliary torque generated with a motor 15 also becomes small and the rotational frequency of a motor 15 moreover falls to one half extent, when sudden steering is performed A rotational frequency higher than the rotational frequency is transmitted to the output shaft of a motor 15 from a steering system. The output shaft of a motor 15 will rotate according to external force, it shifts to a regenerative-braking condition, steering resistance is generated, the steering feeling of a steering wheel becomes heavy according to a run state, and unprepared sudden steering can be prevented.
[0026] Burden detecting signal VL to which has much loading weight of a dc-battery fork lift truck, and it is outputted from the burden sensor 3 on the other hand When large A car will shift to step **c through step **[from step **] b also in the stop condition. If the same steering feeling as the high-speed run state mentioned above can be acquired from the car state variable B being set as "1", a car will start transit in this condition and it will be in a high-speed run state Shift to step **d from step **b, and the car state variable B is set as "2." An output current property is T7 at step **. Since a rotational frequency is set as N12 and the ratio and rotational frequency of the motor output current to a steering torque detecting signal become still smaller While the steering auxiliary torque generated with a motor 15 becomes smaller, a motor 15 can give a bigger steering sense of resistance by being in a regenerative-braking condition, and steering looser than sudden steering can also secure transit stability.
[0027] Thus, while controlling the output torque of a motor according to the steering torque detection value detected by the torque sensor according to the above-mentioned example Since adjustable control of the rotational frequency of a motor can be carried out according to a vehicle speed detection value and/or a burden detection value and these output torque characteristics and a rotational frequency property can be chosen according to the property of an application car It can become possible to apply the control-force control unit 5 to a wide range type of

a car, and versatility can be raised.

[0028] In addition, although this example explained the case where direct detection of the loading object load on a fork was carried out by the burden sensor 31, the wheel load of a steering wheel is detected and you may make it change a rotational frequency corresponding to this wheel load change. Moreover, in this example, although DIP switches 4a-4c were applied as a selection means, it is not limited to this and input means, such as a jumper and a ten key, can be applied.

[0029] Furthermore, although this example explained the case where the both sides of a speed sensor 21 and the burden sensor 31 were applied, as a run state detection means, you may make it omit these either. Although this example described the case where steering auxiliary force-control equipment 2 was constituted from a microcomputer 10 further again, analog control can also be carried out with the application of analog circuits, such as a voltage limiter which restricts a torque detection electrical potential difference according to a function generator, the vehicle speed, or burden, a Pulse-Density-Modulation circuit to which the output is supplied, and a motor drive circuit to which the output is supplied.

[0030] Moreover, what is necessary is for this invention to be applicable not only to this but the fork lift truck of a front-wheel steering mold, and just to set up greatly an output current property and a rotational frequency property in this case in this example, when there is much burden although the fork lift truck of a rear wheel steering mold was explained.

[0031]

[Effect of the Invention] As mentioned above, according to the electromotive power steering concerning this invention, the output current supplied to a motor according to the steering torque detection value of a steering torque detection means is controlled. And a run state detection means detects the run state by the vehicle speed of a car, burden, etc. Since the rotational frequency of a motor is controlled by the control means according to the run state detection value of this run state detection means, many output current properties and rotational frequency properties are beforehand memorized further to storage and this was chosen with the selection means It becomes possible to apply to the type of a car of varieties with one control unit, and the effectiveness that versatility can be raised is acquired.

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]

[Drawing 1] It is the Fig. corresponding to a claim of this invention.

[Drawing 2] It is the block diagram showing one example of the electromotive power steering concerning this invention.

[Drawing 3] It is the characteristic ray Fig. showing the relation between a steering torque detection value and a motor drive current.

[Drawing 4] It is the characteristic ray Fig. showing the relation between the output torque of a motor, a drive current, and a rotational frequency.

[Drawing 5] It is the explanatory view showing the storage table showing the relation between a car property number and a car condition.

[Drawing 6] It is the flow chart which shows processing of a microcomputer.

[Drawing 7] It is the characteristic ray Fig. showing the relation between steering torque and a sensor output.

[Drawing 8] It is the characteristic ray Fig. showing the relation between a sensor output and a motor current.

[Drawing 9] It is the characteristic ray Fig. showing the relation between steering torque and a motor current.

[Description of Notations]

1 Steering Torque Sensor

2 Speed Sensor

3 Burden Sensor

4a-4c DIP switch

5 Steering Auxiliary Force-Control Equipment

10 Microcomputer

11 Storage

14 Motor Drive Circuit

15 Direct Current Motor

[Translation done.]